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NASA APPROVED SPECIFICATION

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CONTROL PROCEDURES.

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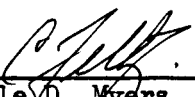
Copy No. 66 CSM END ITEM SPECIFICATION
PART I
PERFORMANCE/DESIGN REQUIREMENTS
SPACECRAFT 2TV-1
FOR
APOLLO CSM SYSTEM
22 September 1965 (U) Contract NAS9-150

SID 66-1347



Exhibit I, Paragraph 4.2

Approved by


Dale D. Myers, Vice President
Apollo Program Manager

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CSM END ITEM SPECIFICATION

PART I

PERFORMANCE/DESIGN REQUIREMENTS

SPACECRAFT 2TV-1

1.0 SCOPE

1.1 Scope. - Part I of this specification establishes the requirements for performance and design of one Apollo Spacecraft (SC) Command/Service Module (CSM) Block II Configuration identified as and hereinafter referred to as Spacecraft 2TV-1. Spacecraft 2TV-1 shall provide capabilities for manned or unmanned thermal/vacuum tests.

1.2 Objective. - The objective of this specification is to serve as a contractual document to provide baseline performance and design requirements for SC 2TV-1 system baseline hardware. Performance and design requirements for SC 2TV-1 shall be in accordance with the Block II configuration defined in Specification SID 64-1345 except for deviations specified herein. Paragraph numbers and titles designated "No change" are listed for convenience in locating common requirements in this specification and Specification SID 64-1345.

2.0 APPLICABLE DOCUMENTS

2.1 Project Documents. - The following documents of the issue date specified form a part of this specification to the extent specified herein. The asterisk (*) adjacent to a document indicates that further review and mutual agreement as evidenced by a supplemental agreement to the Contract is required prior to incorporation of the document into this Specification.

SPECIFICATIONS

North American Aviation, Inc.,
Space and Information Systems
Division (NAA/S&ID)

SID 64-1344
22 February 1965

CSM Technical Specification
Block II

SID 64-1345
22 February 1965

CSM Master End Item
Specification Block II

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*SID 64-1400	Apollo Command Module/Service Module Measurement Requirements SC 2TV-1 Block II
*MH01-07375-100	Work Stand Loadings
*MH01-07376-100	GAEC/NAA Chamb. A Penetrations Mechanical
*MH01-07377-100	GAEC/NAA Chamb. A Equipment
*MH01-07378-100	GAEC/NAA Elec. Power/GRD
*MH01-07380-200	GAEC/NAA Cables to Lunar Plane
*MH01-07381-200	C14-181 (Rev.) to NASA Patch Panel
*MH01-07382-200	C14-181 (Rev.) to NASA Facility Junction Rack
*MH01-07383-200	C14-181 (Rev.) to GE Terminal Patch Panel
*MH01-07384-100	Air Conditioning Requirements
*MH01-07385-100	GAEC/NAA Fl. Supp. Bldgs. 32, 32A, 36
*MH01-07386-200	GAEC/NAA Power/Grounding, Bldg. 32A
*MH01-07387-200	Bldg. 36 Power/Grounding
*MH01-07388-100	Layout of Tank Farm
*MH01-07389-100	Tank Farm Fl. Interfaces
*MH01-07390-100	Tank Farm GSE Cabling
*MH01-07394-100-Bk-II	GSE Arrangement, Bldg. 32 Test Prep Area
*MH01-07395-100-Bk-II	GSE Arrangement, Bldg. 32 Chamber Area
*MH01-07396-100-Bk-II	GSE Arrangement, Bldg. 32A
*MH01-07397-100-Bk-II	GSE Arrangement, Bldg. 36

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2.2 Precedence. - The order of precedence in case of conflict shall be as follows:

- a. The contract
- b. This specification
- c. Other documents referenced herein

3.0 REQUIREMENTS

3.1 Performance. -

3.1.1 Operational Requirements. - Delete the text and substitute:

"The spacecraft shall be designed to be capable of performing the mission defined in Specification SID 64-1344 paragraph 3.1.1.1 Manned Flight through paragraph 3.1.1.2.7 Lunar Excursion Module (LEM) except for the deviations specified herein."

The spacecraft will be used to provide evaluation of the Block II CSM under simulated mission environment (Thermal/Vacuum) conditions and for demonstration that the CSM and its integrated subsystems and crew can reliably operate together in critical environments to which they will be exposed during a mission.

3.1.2 Operability. -

through

3.1.2.5 Transportability. - No change.

3.1.2.6 Human Performance. - Delete the text and substitute:

"Human performance shall be as defined in Specification SID 64-1344 excluding paragraph 3.1.2.6.1.2 Abort Initiation."

3.1.2.7 Safety. -

through

3.1.2.8 Induced Environments. - No change.

3.2 Interface Requirements. - No change.

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3.2.1 Launch Vehicle. - Add the following paragraph (reference SID 64-1344)

"3.2.1.9 Launch Vehicle Interface Control Drawings (ICD's). - The following ICD's describe the equivalent of Launch Vehicle interfaces:

MH01-07375-100	Work Stand Loadings
MH01-07376-100	GAEC/NAA Chamb. A Penetrations Mechanical
MH01-07377-100	GAEC/NAA Chamb. A Equipment
MH01-07378-100	GAEC/NAA Elec. Power/GRD
MH01-07380-200	GAEC/NAA Cables to Lunar Plane
MH01-07381-200	C14-181 (Rev.) to NASA Patch Panel
MH01-07382-200	C14-181 (Rev.) to NASA Facility Junction Rack
MH01-07383-200	C14-181 (Rev.) to GE Terminal Patch Panel
MH01-07384-100	Air Conditioning Requirements
MH01-07385-100	GAEC/NAA Fl. Supp. Bldgs. 32, 32A, 36
MH01-07386-200	GAEC/NAA Power/Grounding, Bldg. 32A
MH01-07387-200	Bldg. 36 Power/Grounding
MH01-07388-100	Layout of Tank Farm
MH01-07389-100	Tank Farm Fl. Interfaces
MH01-07390-100	Tank Farm GSE Cabling
MH01-07394-100-Bk-II	GSE Arrangement, Bldg. 32 Test Prep Area

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MH01-07395-100-Bk-II

GSE Arrangement, Bldg. 32 Chamber Area

MH01-07396-100-Bk-II

GSE Arrangement, Bldg. 32A

MH01-07397-100-Bk-II

GSE Arrangement, Bldg. 36"

3.2.2 Guidance and Navigation. -

through

3.2.3 Crew Equipment. - No change.3.2.4 Scientific Equipment. - No change.3.2.5 GFE-ACE. - Delete the paragraph title and text and substitute:

"Spacecraft GSE Instrumentation Interface. - The hardline from the spacecraft onboard instrumentation subsystem shall interface with the GSE subsystem at the lunar plane disconnect. Power required for the transducers will be supplied to this interface from an external source. The NASA Biomedical Instruments will be powered by the NASA equipment. All signals shall be routed to the GSE subsystem for conditioning and interfacing into the ACE system."

3.2.6 Launch Facility. - Delete.3.2.7 MSFC and MSFN. -

through

3.2.10 Rendezvous Radar Transponder. - No change.3.3 Design and Construction. - No change.3.3.1 General Design Features. - No change.3.3.1.1 General Arrangement. - Delete the text and substitute:

"The general arrangement of SC 2TV-1 is as shown in Figure 1 herein."

3.3.1.2 Design Criteria. - No change.~~CONFIDENTIAL~~

~~CONFIDENTIAL~~3.3.1.3 Weights. -

through

3.3.16 Ground Support Equipment. - No change.3.4 Requirements of Sub-Areas. - No change.3.4.1 Command and Service Modules. - No change.3.4.1.1 CSM Structural Subsystem. - No change.3.4.1.1.1 Launch Escape Tower. - Delete.3.4.1.1.2 Command Module. -

through

3.4.1.1.2.1 Command Module Structure Subsystem Requirements. - No change.3.4.1.1.2.2 Command Module Structure Subsystem Function. - Add to the end of item h - the following sentence:

"The right hand side window shall be replaced with a cabling and tubing feed-through panel."

3.4.1.1.2.3 Command Module Structure Description. -

through

3.4.1.1.2.4.2.3 Astro-Sextant Door Mechanism Interface. - No change.

3.4.1.1.2.4.3 Side Access Hatch Cover Latching Mechanisms. - In the third line delete the word "three". Delete item c in its entirety. In the first line of the last paragraph delete the word "three".

3.4.1.1.2.4.3.1 Design Features. - Delete item c in its entirety.3.4.1.1.2.4.3.2 Side Access Hatch Cover Latching Mechanism Performance. -

through

3.4.1.1.2.6.6.1.6 Sea Pick-Up Provisions. - No change.~~CONFIDENTIAL~~

~~CONFIDENTIAL~~3.4.1.1.3 Service Module Structure Subsystem. -

through

3.4.1.1.3.1.1.4 Ground Support Equipment (GSE). - No change.3.4.1.1.3.1.1.5 Spacecraft LEM Adapter. - Delete.3.4.1.1.3.1.1.6 Electrical Power System (EPS). -

through

3.4.1.1.3.1.1.8 Electrical Wiring. - No change.

3.4.1.1.3.1.1.9 Delete "Intentional Blank" and substitute the following:

"Service Module Test Hard Lines. - Provisions shall be made for adding test hard lines into the Service Module."

3.4.1.1.3.1.1.10 Communications. -

through

3.4.1.1.3.3.9 Micrometeoroid Protection. - No change.3.4.1.1.3.3.10 Insulation. - Add the following sentence at the end of the paragraph:

"Vent valves in the SM aft heat shield shall not be provided. The openings for the valves and valve mounting provisions shall be provided."

3.4.1.1.3.3.11 System Support. - No change.3.4.1.1.4 Spacecraft LEM Adapter (SLA). -

through

3.4.1.1.4.4.7 Mission Sequencers. - Delete.3.4.1.1.5 Docking Subsystem. -

through

3.4.1.1.5.1.1.1 Probe Body. - No change.~~CONFIDENTIAL~~

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3.4.1.1.5.1.1.2 Probe Head. - Last sentence, between the words "release" and "LEM" add: "from the."

3.4.1.1.5.1.1.3 Pitch Arm and Tension Linkage. -
through

3.4.1.1.5.4 Subsystem Interfaces. - No change.

3.4.1.2 Mission Support. - No change.

3.4.1.2.1 Electrical Power Subsystem (EPS). - First sentence, delete "SID 64-1344" and substitute: "this specification."

3.4.1.2.1.1 Electrical Power Subsystem (EPS) Requirements. - Delete the text (except Table VII) and substitute:

"EPS equipment shall provide electrical power as shown in Figure 2 herein. The electrical power requirements shall be satisfied by the use of three fuel cell modules during the main portion of the mission and by storage batteries during the reentry and post landing phases. The total net energy will not be limited to the spacecraft cryogenic tank reactant supply due to direct hard line installation. The electrical power shall be supplied to the subsystems as delineated in Table VII."

3.4.1.2.1.1.1 Load Grouping. -
through

3.4.1.2.1.1.7.1 Energy Sources. - No change.

3.4.1.2.1.1.7.1.1 Cryogenic Storage Section. - Delete the first sentence and substitute:

"The cryogenic storage section, through a system of tanks and plumbing may be used to provide oxygen and hydrogen as necessary for the operation of the fuel cell modules. Provision shall be made to provide reactants to the power generation section from reactant supplies external to the Service Module (SM). Subsystem capabilities are described herein for possible systems operation or checkout."

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~~CONFIDENTIAL~~3.4.1.2.1.1.7.1.1.1 Storage Tanks. -

through

3.4.1.2.1.1.7.4.1 Protection. - No change.3.4.1.2.1.1.7.4.2 Operating Conditions. - Add to the end of the paragraph:

"See Figure 3 herein for the EPS bus structure schematic. Spacecraft 2TV-1 remote control provisions shall be made for remote operations of manually operated functions as specified in paragraph 3.4.1.4.5.6.15."

3.4.1.2.2 Environmental Control Subsystem (ECS). - No change.3.4.1.2.2.1 Environmental Control Subsystem Requirements. - Add to the end of the paragraph:

"Provisions shall be made for removal of cabin and suit loop gases for analysis both on-board and external to the vehicle, by means of valving external to the command module."

3.4.1.2.2.2 ECS Circuits. - No change.3.4.1.2.2.2.1 Pressure Suit Circuit (PSC). - Add to the end of the paragraph:

"Provisions shall be made for installation and control of two suit loop stimuli generators (GFE) for unmanned tests of the ECS. One in the PSC at an access point, and one in the cabin space."

3.4.1.2.2.2.1.1 Pressure Suit Circuit (PSC) Component Description. -

through

3.4.1.2.2.2.2 Temperature Control Circuit (TCC). - No change.3.4.1.2.2.2.3 Pressure Control Circuit (PCC). - Add to the end of item b:

"Provisions shall also be made for remote shut-off of emergency oxygen inflow following cabin depressurization by a one-half inch diameter micrometeoroid puncture simulation."

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3.4.1.2.2.2.3.1 Pressure Control Circuit (PCC) Components. - After item f, add:

"g. Micrometeoroid Puncture Simulation Valve. - A solenoid operated valve shall be provided to simulate a one-half inch diameter micrometeoroid puncture for test of the ECS."

3.4.1.2.2.2.4 Water Control Circuit (WCC). -

through

3.4.1.2.2.2.4.1 Water Control Circuit (WCC) Components. - No change.

3.4.1.2.2.2.5 Waste Management Circuit (WCM). - Add to the end of item b:

"The waste management system urine subcircuit shall be modified to operated in a one-g environment. An overboard urine line shall be provided."

3.4.1.2.2.2.5.1 Waste Management Circuit (WMC) Components. -

through

3.4.1.2.2.3 ECS Electrical Power Requirements. - No change.

3.4.1.2.3 Crew Equipment Subsystem. -

through

3.4.1.2.3.11.12 LEM Active Docking and Alignment Sight and Target. - No change.

3.4.1.3 Navigation, Guidance, Control and Propulsion. - No change.

3.4.1.3.1 Integrated Guidance and Control Subsystem (G&C). -

through

3.4.1.3.1.4.3 Government Furnished Equipment. - No change.

3.4.1.3.2 Command Module Reaction Control Subsystem (CM/RCS). -

through

3.4.1.3.2.2.5.7 Positive Sealing Provisions. - No change.

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3.4.1.3.3 Service Module Reaction Control Subsystem (SM/RCS). -

through

3.4.1.3.3.2.10.6 Test Ports. - No change.

3.4.1.3.4 Service Propulsion Subsystem. -

through

3.4.1.3.4.1.9.8.2 Stud Feed-Through. - No change.

3.4.1.4 Sequencing, Sensing, and Recovery. - Delete item b.

3.4.1.4.1 Sequential Events Control Subsystem (SECS). -

through

3.4.1.4.1.4.1.7 Apollo LEM Abandonment Events Sequence. - No change.

3.4.1.4.2 Launch Escape Subsystem (LES). -

through

3.4.1.4.2.6.11.5 Thermal Protection. - Delete.

3.4.1.4.3 Earth Recovery Subsystem (ERS). -

through

3.4.1.4.3.2 PS Equipment. - No change.

3.4.1.4.3.3 Drogue Parachute. - At end of second sentence add a sentence as follows:

"The reefing line cutters shall not contain explosives. Dual reefing systems consisting of two reefing lines without reefing line cutters shall be incorporated in each canopy. The cutters shall be marked externally in a visible location as follows: 'NOT FOR FLIGHT'."

3.4.1.4.3.3.1 Drogue Parachute Deployment Bag. -

through

3.4.1.4.3.3.2 Drogue Parachute Riser. - No change.

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3.4.1.4.3.3.3 Drogue Parachute Mortar Assembly. - Delete last sentence and substitute:

"No pyrotechnic cartridges shall be supplied. The mortar shall be marked externally in a visible location as follows: 'NOT FOR FLIGHT'."

3.4.1.4.3.3.4 Drogue Mortar Pyrotechnic Cartridge. - Delete.

3.4.1.4.3.3.5 Drogue Disconnect Assembly. - Delete the text and substitute:

"Drogue disconnects shall be provided, however; no pyrotechnic cartridges shall be provided."

3.4.1.4.3.4 Main Parachute Assembly. -
through

3.4.1.4.3.4.1.3 Pilot Parachute Riser. - No change.

3.4.1.4.3.4.1.4 Pilot Parachute Mortar Assembly. - Delete the last sentence and substitute:

"No pyrotechnic cartridges will be supplied with this unit. The mortar shall be marked externally in a visible location as follows: 'NOT FOR FLIGHT'."

3.4.1.4.3.4.1.5 Pilot Parachute Mortar Pyrotechnic Cartridges. - Delete.

3.4.1.4.3.5 Main Parachute Pack Assembly. -
through

3.4.1.4.3.5.1.2 Main Parachute Riser. - No change.

3.4.1.4.3.5.1.3 Reefing Line Cutters. - Add the following sentence:

"Reefing line cutters shall not contain pyrotechnics."

3.4.1.4.3.6 Main Cluster Disconnect Assembly. -
through

3.4.1.4.3.7.4 Sequence Control Static Pressure Source. - No change.

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through

3.4.1.4.4.5.4.3 Schematic. - No change.3.4.1.4.5 Display and Control Subsystem (D&C). - No change.3.4.1.4.5.1 Subsystem Requirements. -

through

3.4.1.4.5.6.14 Heat Transfer. - No change.3.4.1.4.5.6.15 Added Functions. - Add the following new paragraph:

"3.4.1.4.5.6.15 Added Functions. - Remote control system provisions shall be made to remotely control various spacecraft functions required to support the thermal/vacuum test mission. This system will provide for access points within the SC electrical wiring and remote relays to effect the required switching functions summarized as follows:

Control System FunctionControl Action

NOTE: Numbers in parentheses indicate the number of stimuli required from the External Digital Command Test Set.

SPS (20)

Helium Isolation Valve Control (6)
(Two valves coactuated)

Auto-Manual-Off (6)

Gimbal Actuator Motor Start
Controls (12) (Four actuators, each
selectable)

Start-On-Off (12)

Pilot Valve (2)

On-Off (2)

Control System FunctionControl ActionRCS-CM (4)

Helium Isolation Valve Controls (2)
(Four valves coactuated)

Open-Close (2)

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<u>Control System Function</u>	<u>Control Action</u>
Propellant Isolation Valve Controls (2) (Four valves coactuated)	Open-Close (2)
<u>RCS-SM (4)</u>	
Helium Isolation Valve Controls (2) (Two valves coactuated)	Open-Close (2)
Propellant Isolation Valve Controls (2)	Open-Close (2)
<u>Electrical Power System (25)</u>	
A-C Alarm Reset (2)	Reset
A-C Inverter Switches (7)	Bus No. 1 & No. 2 (2) No. 1 & No. 2 On-Off (4) No. 3 Bus A, Bus B, Off (3)
A-C Inverter to A-C Bus Selection (12)	On-Off (12)
Entry Batteries On-Off Main DC Bus Control (4) (Two batteries, each selectable)	E/B "A" On-Off (2) E/B "B" On-Off (2)
<u>Environmental Control System (31)</u>	
ECS Space Radiator Isolation Valve Controls (8) (Four valves, each selectable)	Open-Close (8)
Wetness Control Water Valve Controls (2)	Auto-Off (2)
Cabin Blower & Suit Compressor System Nos. 1 & 2 Controls (8) (Four system, each selectable)	C/B No. 1 On-Off (2) C/B No. 2 On-Off (2) S/C No. 1 On-Off (2) S/C No. 2 On-Off (2)
Emergency O ₂ Flow Remote Shutoff (2)	Operate - Off (2)
ECS Glycol Pump Control (4) (Two systems, each selectable)	Syst. 1 On-Off (2) Syst. 2 On-Off (2)
Micrometeoroid Puncture Simulation Valve	Open-Close (1)

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<u>Control System Function</u>	<u>Control Action</u>
CM Depressurization Valve Controls (2)	Open-Close (2)
Water Makeup Supply Line Shutoff Valve Controls (2)	Open-Close (2)
Glycol Temp. Valve Controls (2)	On-Off (2)
<u>Guidance and Navigation System (6)</u>	
IMU/CDU Control (2)	Standby-Operate (2)
AGC Power (2)	On-Off (2)
Optical Power (2)	On-Off (2)
<u>Sequential Events Control Subsystem (SECS) (3)</u>	
CM-SM Separation (1)	On (1)
Earth Landing Sequential Controller (ELSC) ELSC Actuate (2)	On-Off (2)
Remote Control Relay Box (RCRB) (2)	
Excitation Power Control-Sensor (2) (Biomed Suit Outlet Humidity)	On-Off (2)
<u>Stabilization and Control Subsystem (SCS) (2)</u>	
Gimbal Control (Pitch and Yaw)	Analog Voltage (2)"

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3.4.1.5 Information Acquisition. - Delete the text and substitute:

"This section contains performance and design requirements for the subsystems required for thermal vacuum test spacecraft 2TV-1 for performance measurement, signal conditioning, data storage, video, RF trajectory measurement and communication of information between the Apollo CSM system and the CSM Extra Vehicular Astronaut (EVA), the Apollo LEM system and the Manned Space Flight Network (MSFN) and deployed recovery forces as simulated by operation via RF hardline connection with the GSE and ACE systems instead of with the antennas. The antennas shall be installed on the spacecraft. Subsystems included are:

- a. Communication
- b. Instrumentation

A block diagram for the Communication and Instrumentation subsystems for SC 2TV-1 is shown in figure 4 herein."

3.4.1.5.1 Communications Subsystem. -

through

3.4.1.5.1.3.26 Command Relays. - No change.

3.4.1.5.2 Instrumentation Subsystem. -

through

3.4.1.5.2.3 Operating Conditions. - No change.

3.4.1.5.2.4 Subsystem Interface Requirements. - Delete the following items:

- "e. Earth Recovery
- h. Launch Escape
- 1. Launch Vehicle - Emergency Detection System (EDS)
- m. SLA."

3.4.1.5.2.4.1 Instrumentation Interface Requirements. -

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3.4.1.5.2.5.3 Wiring Interface Requirements. - No change.

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3.4.1.5.2.6 Subsystem Description. - Delete the text and substitute:

"The measurements to be provided on SC 2TV-1 shall be divided into two major categories: Operational, and Environmental Test."

3.4.1.5.2.6.1 Operational Instrumentation. - Delete the third sentence and substitute:

"Specification SID 64-1400 gives the baseline measurements comprising the operational instrumentation subsystem."

Delete the following items:

"o. Angle of Attack/Sideslip

Delete paragraph starting with: "Table XXVIII contains. . . ." and substitute:

"The operational measurements are defined as those remaining fixed for a series of spacecraft consigned to a similar type mission. These measurements are in support of an Apollo CSM LOR spacecraft with a LEM. These measurements are further categorized as follows:

- a. Category I - Spacecraft In-Flight Management - Measurements that give the condition of vital consumable items, provide required spacecraft performance information, indicate critical operation sequencing and provide maximum crew safety.
- b. Category II - Mission Evaluation and System Performance - Measurements that require ground monitoring for flight operation purposes.
- c. Category III - Spacecraft Preflight Checkout - Measurements required for ground checkout for ensuring flight readiness and proper system operation."

3.4.1.5.2.6.1.1 Pressure Measuring. -

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3.4.1.5.2.6.1.1.4.3 Crew Pressure Suit Instrumentation. - No change.

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3.4.1.5.2.6.1.15 Angle of Attack. - Delete.

3.4.1.5.2.6.1.16 Phase Measuring. -

through

3.4.1.5.2.9 Scientific Equipment. - No change.

3.4.1.5.2.10 Additional Instrumentation Requirements. - Delete the text and substitute:

"3.4.1.5.2.10.1 Environmental Test Measurements. - Additional instrumentation shall be provided for obtaining environmental test measurements which shall be transmitted by hardline.

3.4.1.5.2.10.2 Hardline Instrumentation Subsystem. - This subsystem shall be added to support the Thermal/Vacuum test program and shall include the requirements specified in the following subparagraphs.

3.4.1.5.2.10.2.1 Subsystem Requirements. - Sensors for detecting physical phenomena and converting them into electrical signals shall be installed. These signals shall be hardlined to signal conditioning and multiplexing equipment remote to the spacecraft.

3.4.1.5.2.10.3 Subsystem Description. - The following measuring subsystems shall be provided to that degree required to implement the requirements of Specification SID 64-1400.

3.4.1.5.2.10.3.1 Temperature Measuring Subsystems. - The spacecraft structure and various spacecraft systems shall be instrumented to measure spacecraft thermal response. To obtain the required temperature data, three types of temperature measurement subsystems shall be used; thermocouples, resistance temperature sensors, and differential temperature measurement subsystems.

3.4.1.5.2.10.3.1.1 Thermocouple Type. - Copper-constantan shall be used for all thermocouple measurements. The hot reference junction will be a part of the environmental test facility. Five types of thermocouples shall be used. Following are types of thermocouples, their measurement applications and methods of installation.

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<u>Type Thermocouple</u>	<u>Measurement Application</u>	<u>Method of Installation</u>
Bead	Ablator Surface	Bonded
Ball	Tubing	Clamped
Fine Wire	Surface	Welded
Grid	Tanks	Self-Adhesive or Bonded
Disc	Radiators	Bonded

3.4.1.5.2.10.3.1.2 Resistance Type. - Platinum resistance probes shall be used for temperature measurements whose total temperature span is less than 100 degrees F. Excitation power and signal conditioning circuitry shall be supplied from an external source.

3.4.1.5.2.10.3.1.3 Differential Type. - Differential type temperature sensors shall be used on both the EPS and ECS radiators. Temperature sensors, each containing two elements shall be installed on the input and output lines of the radiators. Excitation power and signal conditioning circuitry shall be supplied from an external source.

3.4.1.5.2.10.3.2 Flow Measuring Subsystem. - Means shall be provided to obtain volumetric measurements of air, glycol and water; and mass flow measurements of glycol and water. Data obtained shall be used in evaluating the performance of the environmental control and the electrical power subsystems. Volumetric measurements shall be made by measuring the pressure drop across a calibrated restriction. The measured temperature shall be monitored to correct flow data as required. Mass measurements shall be made by using a thermal flowmeter.

3.4.1.5.2.10.3.3 Strain Measuring Subsystem. - Bonded strain gage transducers shall be used to measure stress on the CM heat shield which results from thermal cycle conditions. Strain elements shall be welded onto both the inner and outer surface of the stainless steel honeycomb. The strain element on the inner surface will be directly opposite the element on the outer surface. Bridge excitation and null balance shall be supplied from an external source.

3.4.1.5.2.10.3.4 Pressure Measurement Subsystem. - Means shall be provided to make both absolute and differential pressure measurements. These measurements will be made to support the evaluation of the suit circuit, water-glycol system, and the waste management system. As noted in the flow measuring subsystem, pressure transducers will be used to obtain flow data. Excitation power will be supplied from an external source.

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3.4.1.5.2.10.3.5 Displacement Measuring Subsystem. - Means shall be provided to measure movement of the CM side heat shield with respect to the CM inner structure to determine the effects of cyclic thermal conditions. The excitation power for these transducers will be supplied from an external source.

3.4.1.5.2.10.3.6 Velocity Measuring Subsystem. - Means shall be provided to measure the amount of air circulated by the cabin fans. A flow transducer shall convert the circulation rate into a proportional electrical signal which shall be conditioned by an external source.

3.4.1.5.2.10.3.7 Heat Flux Measuring Subsystem. - Means shall be provided to measure the heat absorption and radiation reflection rates of the heat shield. The transducers shall be installed at various locations on the surface of the CM. Installation locations may vary from test to test.

3.4.1.5.2.10.4 Hardline Operational Measurements. - Operational measurements subsystems associated with the safety of crew personnel shall be transmitted by hardline as well as by the PCM telemetry subsystem. Included are the following types of measurements:

- a. Pressure
- b. Temperature
- c. Quantity
- d. Events

3.4.1.5.2.10.5 Hardline Life Systems Measurements. - The hardline instrumentation will be utilized for transmission of measurements made on the astronauts and their pressure unit environments. All measurement hardware except for three temperature measurements, will be NASA/GFE. Types of measurements by the NASA/GFE include:

- a. Pressure
- b. Temperature
- c. Humidity
- d. Biomedical, including chamber safety biomedical instrumentation package.
- e. Events.

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3.4.1.5.2.10.6 Power Distribution Boxes. - Power distribution boxes shall be provided. Distribution boxes will be used for the following measurement subsystems:

- a. Strain Measurement Subsystem
- b. Displacement Subsystem
- c. Pressure Measurement Subsystem

Power distribution boxes will be located in each of the following spacecraft areas:

- d. CM Crew Compartment
- e. CM Aft Compartment
- f. Service Module
- g. CM Forward Compartment."

3.4.1.5.2.10.7 Spacecraft GSE Instrumentation Interface. - The spacecraft onboard Hardwire Instrumentation Subsystem shall interface with the GSE subsystem at the Lunar Plane Disconnect. Power required for the transducers shall be supplied to this interface from an external source. NASA Biomedical Instruments will be powered by NASA equipment. All signals shall be routed to the GSE for conditioning and interfacing into the ACE system."

3.4.2 Training Equipment. -

through

3.4.3 Ground Support Equipment. - No change.

3.4.4 Other Equipment. - Delete.

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4.0 QUALITY ASSURANCE PROVISIONS

4.1 General Quality Assurance Program. -

through

4.1.1 Quality Control. - No change.4.2 Reliability. -

through

4.3 Test. - No change.4.4. Configuration Management Provisions. -

through

4.4.1 Change Control. - No change.

5.0 PREPARATION FOR DELIVERY

through

5.2.4 Transport. - No change.

6.0 NOTES

This section of this specification is not contractually binding. All information contained herein is for information purposes only.

6.1 Definitions. -

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6.1.5 Acronyms. - No change.

10. APPENDIX

Not applicable.

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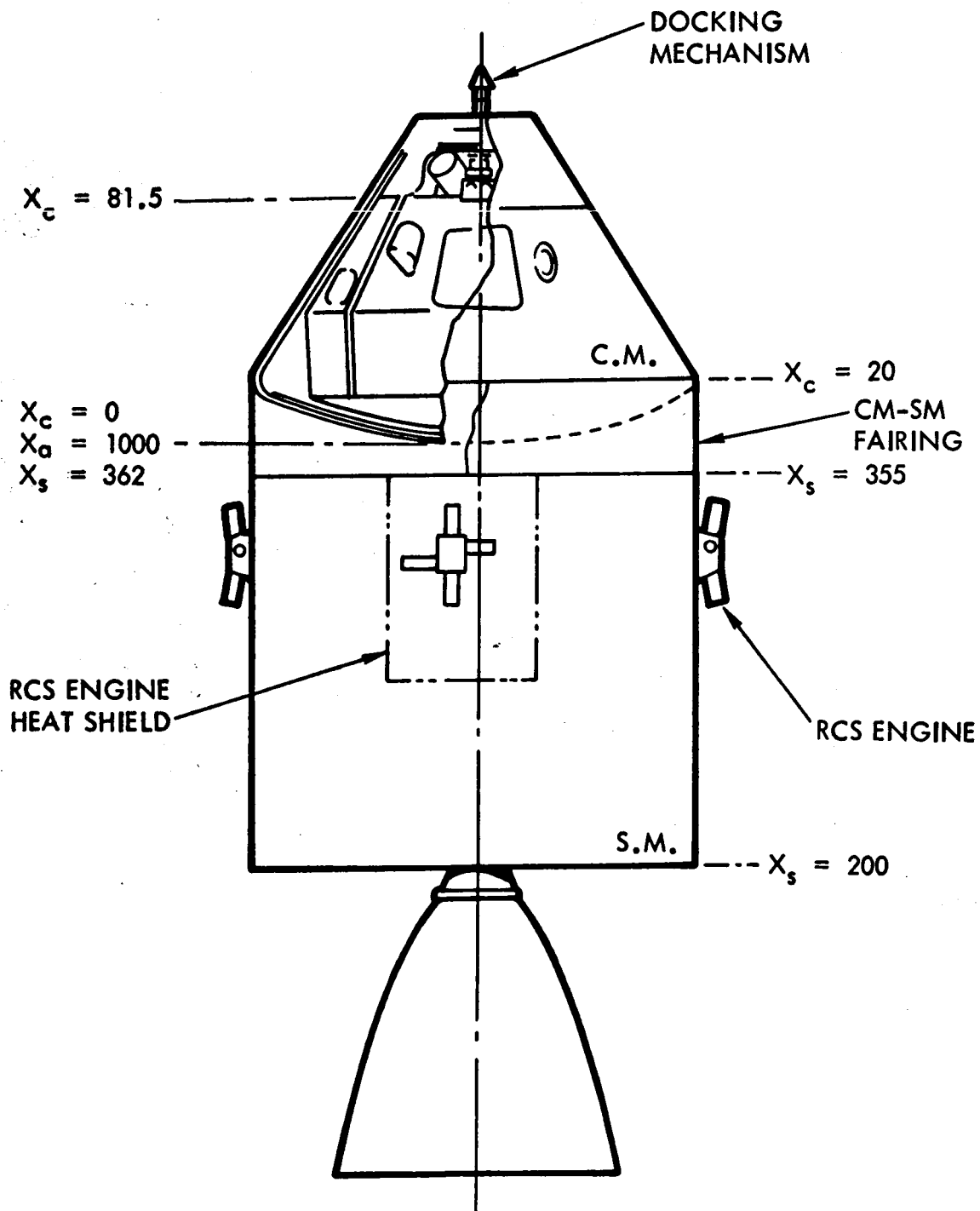
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Figure 1. General Arrangement (SC 2TV-1)

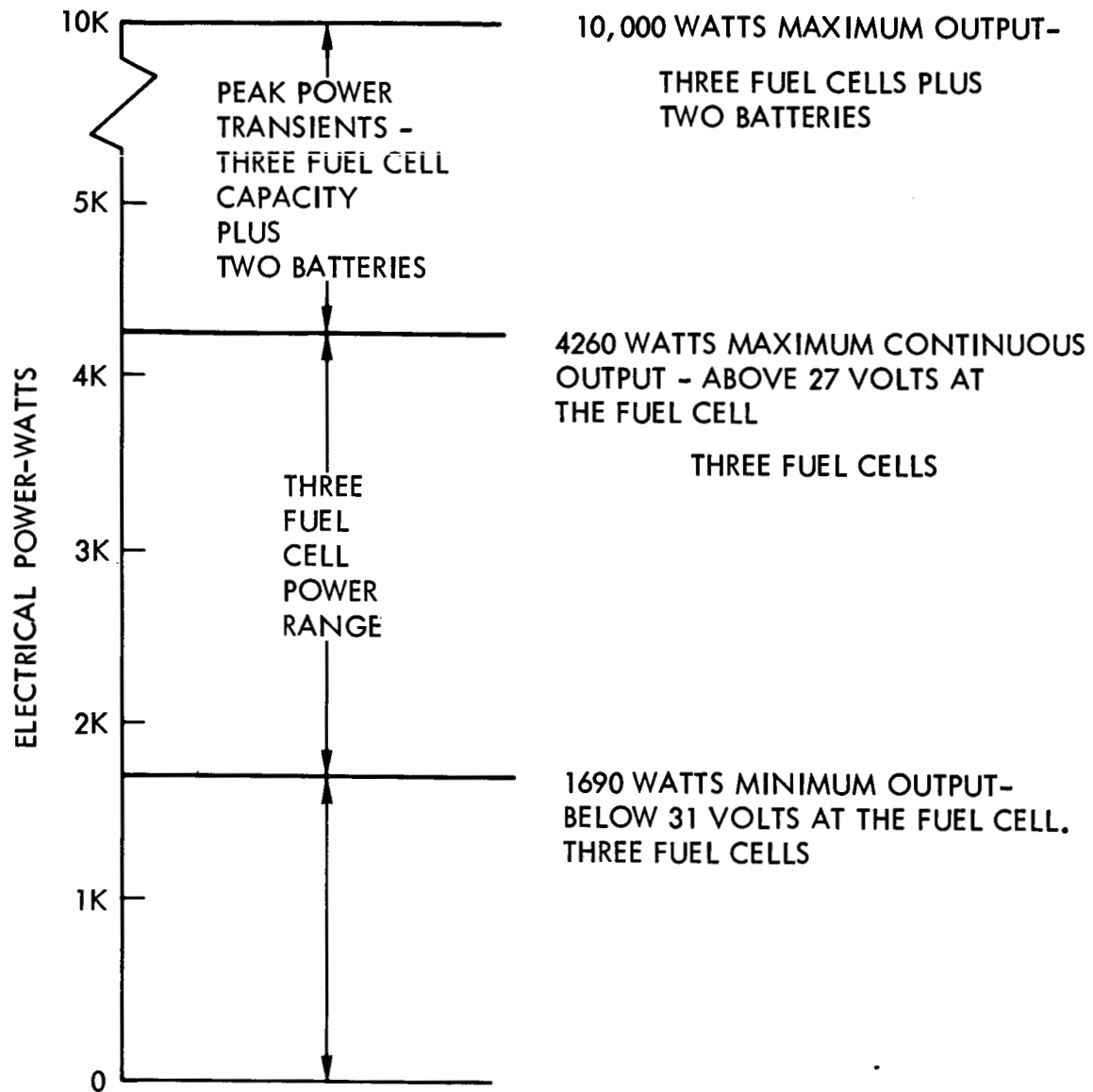
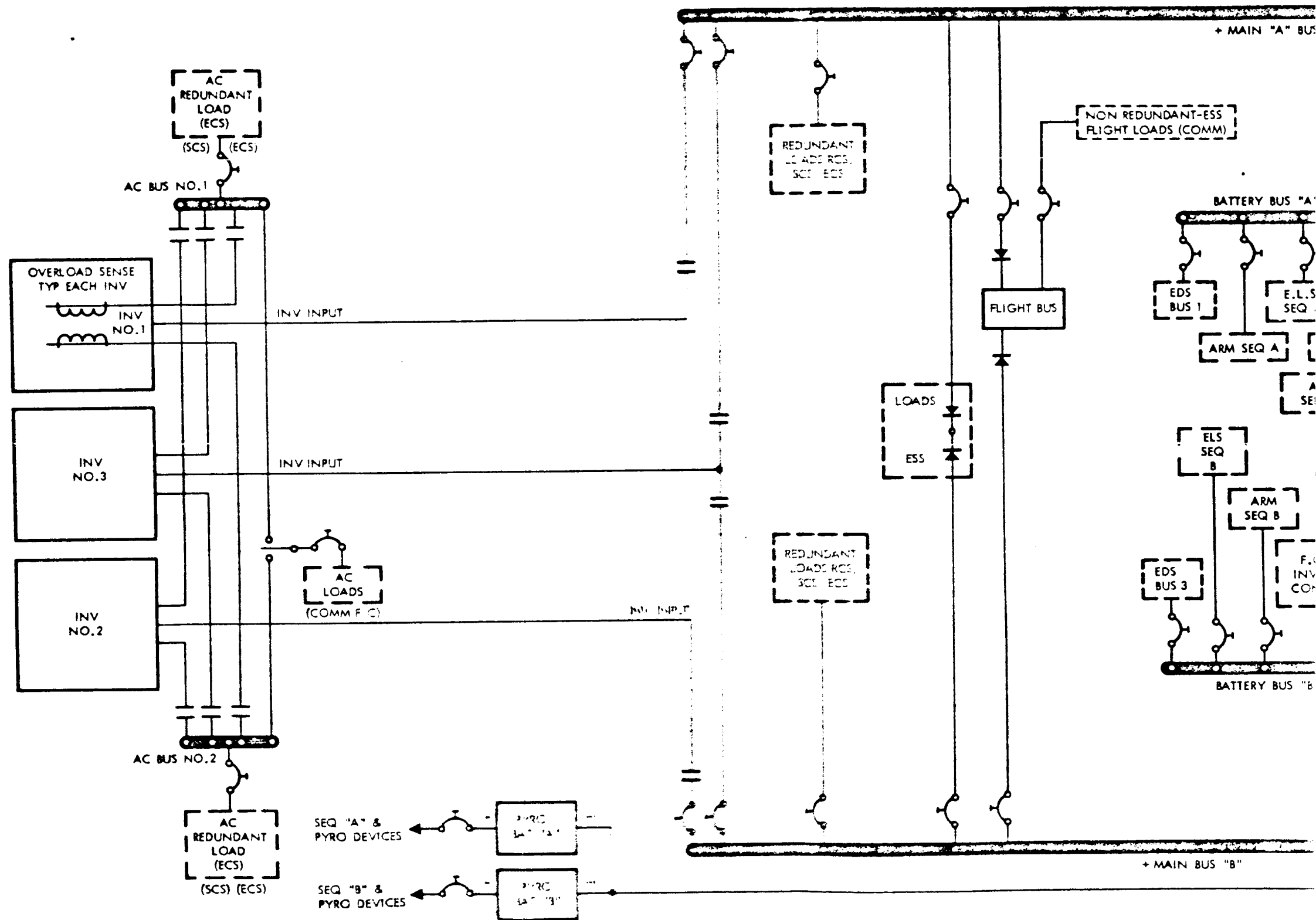
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Figure 2. Electrical Power Subsystem Power Output

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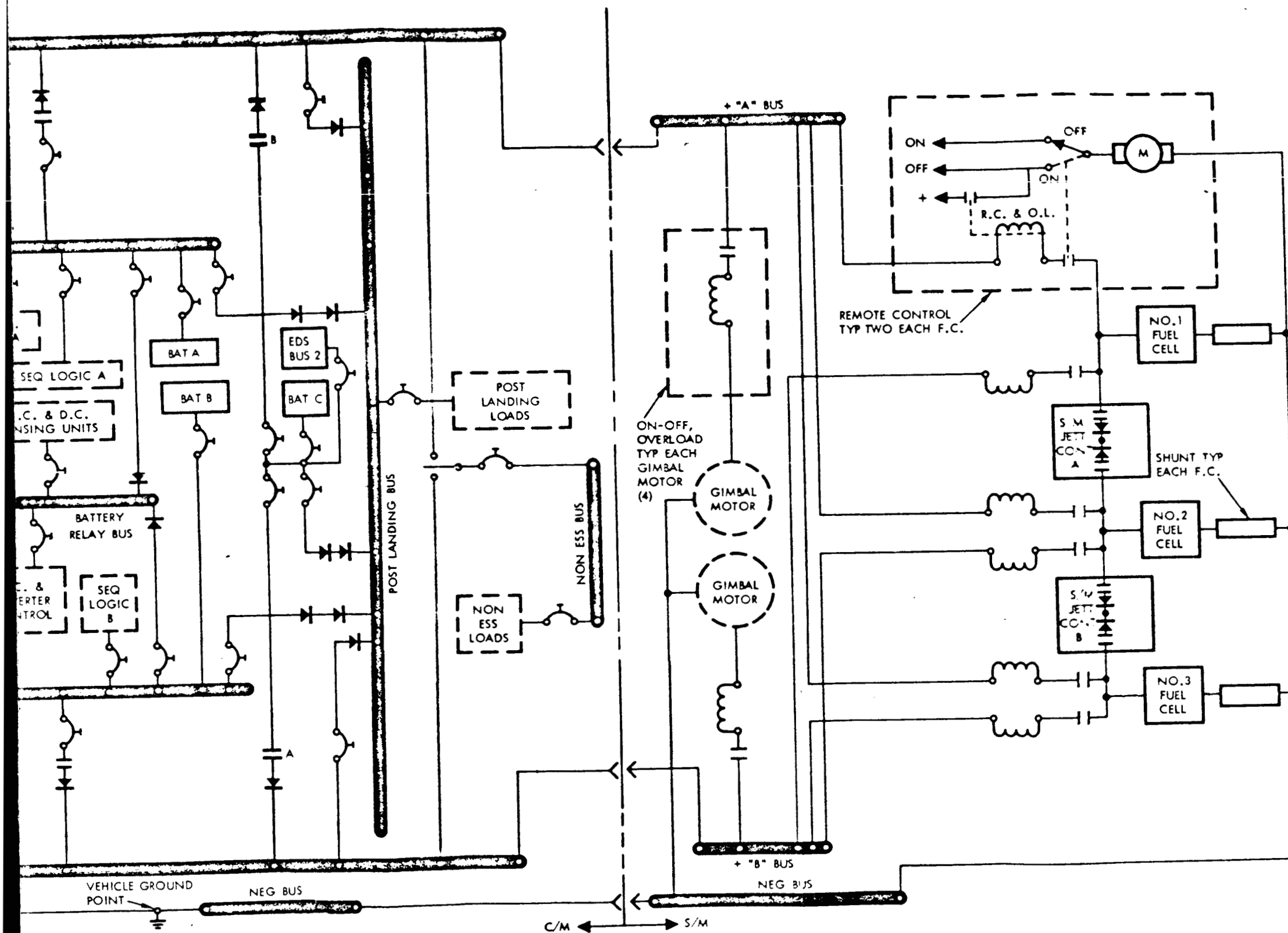
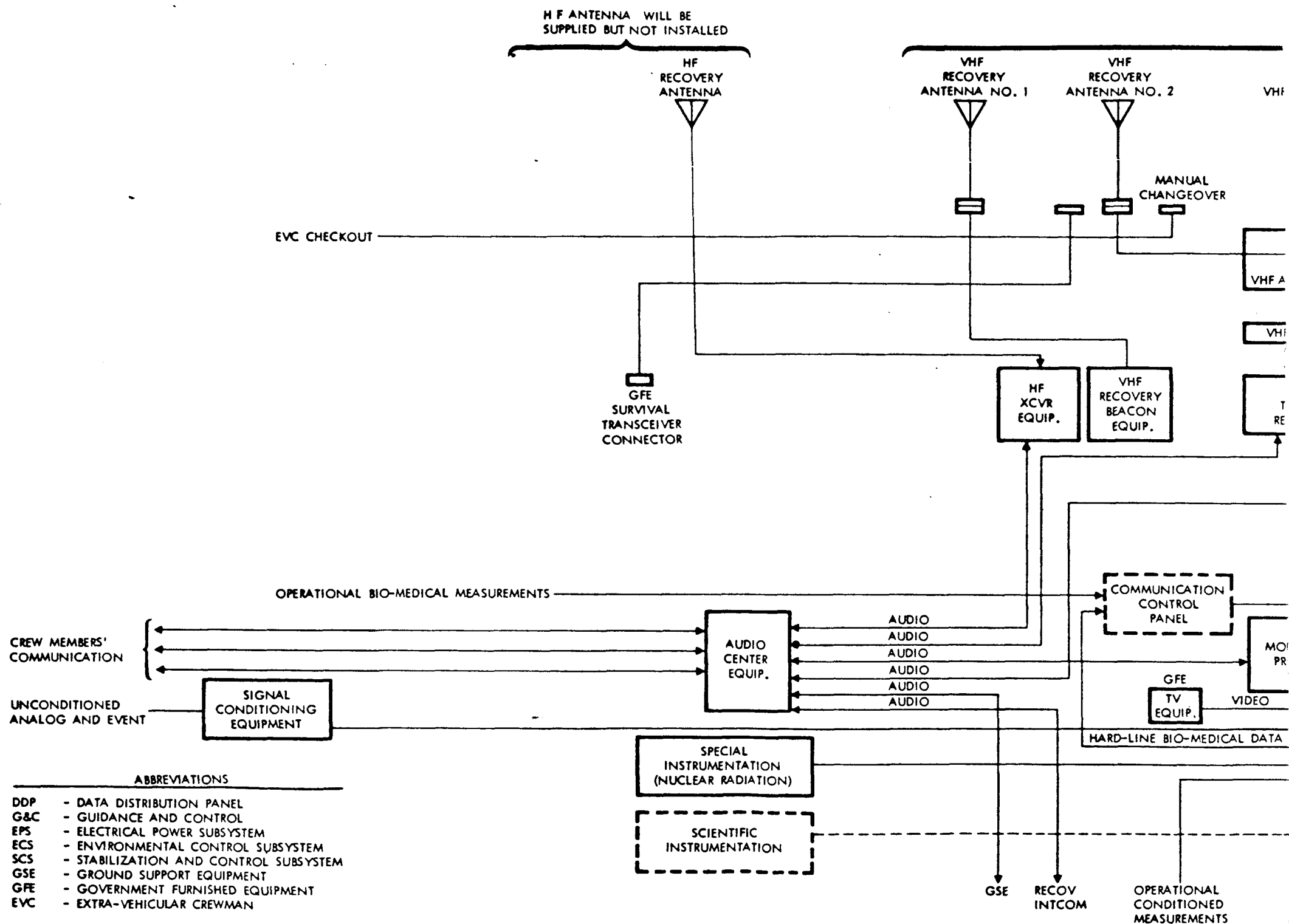


Figure 3 EPS Bus Structure Block II-SC 2T /-1

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ANTENNAS WILL BE DISCONNECTED WHEN REQUIRED TO PERMIT
CONNECTION OF COAXIAL CABLES IN ENVIRONMENTAL CHAMBER

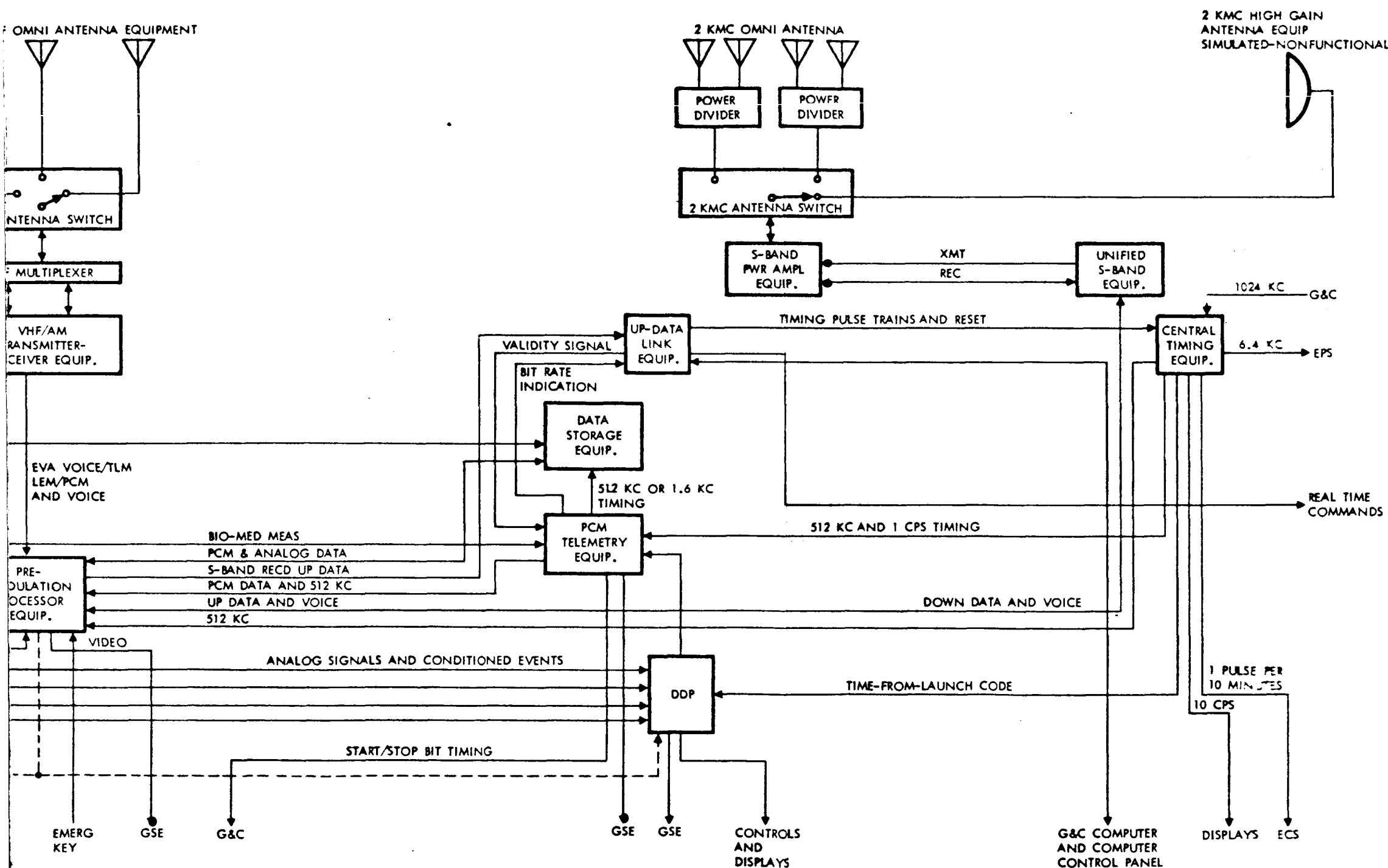


Figure 4. Block Diagram of Communication and Instrumentation Subsystems SC ZTV-1

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